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Off-normal and failure condition analysis of the MITICA negative-ion Accelerator

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MITICA is the prototype of the Heating Neutral Beam Injectors (HNB) for ITER and is constituted by a negativeion source, a multi-grid electrostatic accelerator, a neutralizer and a residual ion dump. The injector is designed to produce a 17 MW beam of neutral particles (deuterium or hydrogen) up to 1 MeV. Two HNBs are planned to be installed in ITER at Cadarache, France. MITICA is under construction in the PRIMA facility in Padova, Italy. The design of MITICA/HNB [1] has required extensive optimizations in order to guarantee that the thermomechanical stresses in the materials do not exceed the tolerable limits for the required fatigue life. This result has been achieved by: (a) reducing and uniforming the heat loads on the accelerator grid and beam line components, and (b) improving the heat removal capability of the active cooling system of the grids. This involved an extensive optimization of the electric and magnetic field configuration and of the geometry of the accelerator grids,
suppressing the electrons before they are accelerated at higher energy, and improving the optics of the ion beamlets.

However, deviation from the expected magnetic and electrostatic configuration can be caused by "off-normal" or "failure" operating conditions of the accelerator, such as undesired mechanical displacement of the grids, nonuniform extracted ion current, demagnetization of magnets, partial failure of the accelerator grid power-supplies and also operation with different ion species.

Purpose of the present work is to analyse and identify the "off-normal" operating conditions which could possibly become critical in terms of thermomechanical stresses or of degradation of the optical performances of the beam, and to give indications on protective actions to be taken.

References

[1] V. Antoni et al.: "Physics design of the injector source for ITER neutral beam injector " Rev. Sci. Instrum. 85, 02B128 (2014), DOI: 10.1063/1.4857235

Disclaimer

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